# Triple Ionization of Lithium

M.T. Huang, W. Wong, S. Hasegawa[1], S.H. Southworth, L. Young

Recently we have made the first observation of triple ionization of lithium by electron impact under single collision conditions. We used ultracold atoms in a magneto-optical trap (MOT) combined with a time-of-flight ion spectrometer. Here the clean environment of the MOT played a critical role as the $H_2^+$, the wings of which form the major background interference with $Li^{3+}$, was reduced substantially over what is typically obtained in thermal atomic beams. The cross-section was found to be surprisingly small: two orders of magnitude smaller than the semi-empirical estimate, which predicts a factor of ten difference between $Li^{3+}$ and $Li^{2+}$. The observed cross-section ratios at an electron impact energy of 1000 eV [$Li^{3+}/Li^{2+}/Li^+ \approx 4 \times 10^{-6} : 4 \times 10^{-3} : 1$] are smaller than those observed in photoionization by roughly a factor of 10. The ratio of triple-to-double ionization in lithium, $\approx 10^{-3}$, is substantially smaller than in any other atom observed to date.

For triple ionization, in contrast to double ionization, predictions for cross sections are limited to semi-empirical calculations; *ab initio* theoretical work is currently non-existent. As an object of study, lithium holds special interest as the simplest three-electron system and as a bridge to more complex systems. These experimental results are expected to spur further development of theoretical methods to describe the ejection of many charged particles into the continuum.

[1] University of Tokyo